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THE MIAMI CONSERVANCY BULLETIN

JANUARY 1920

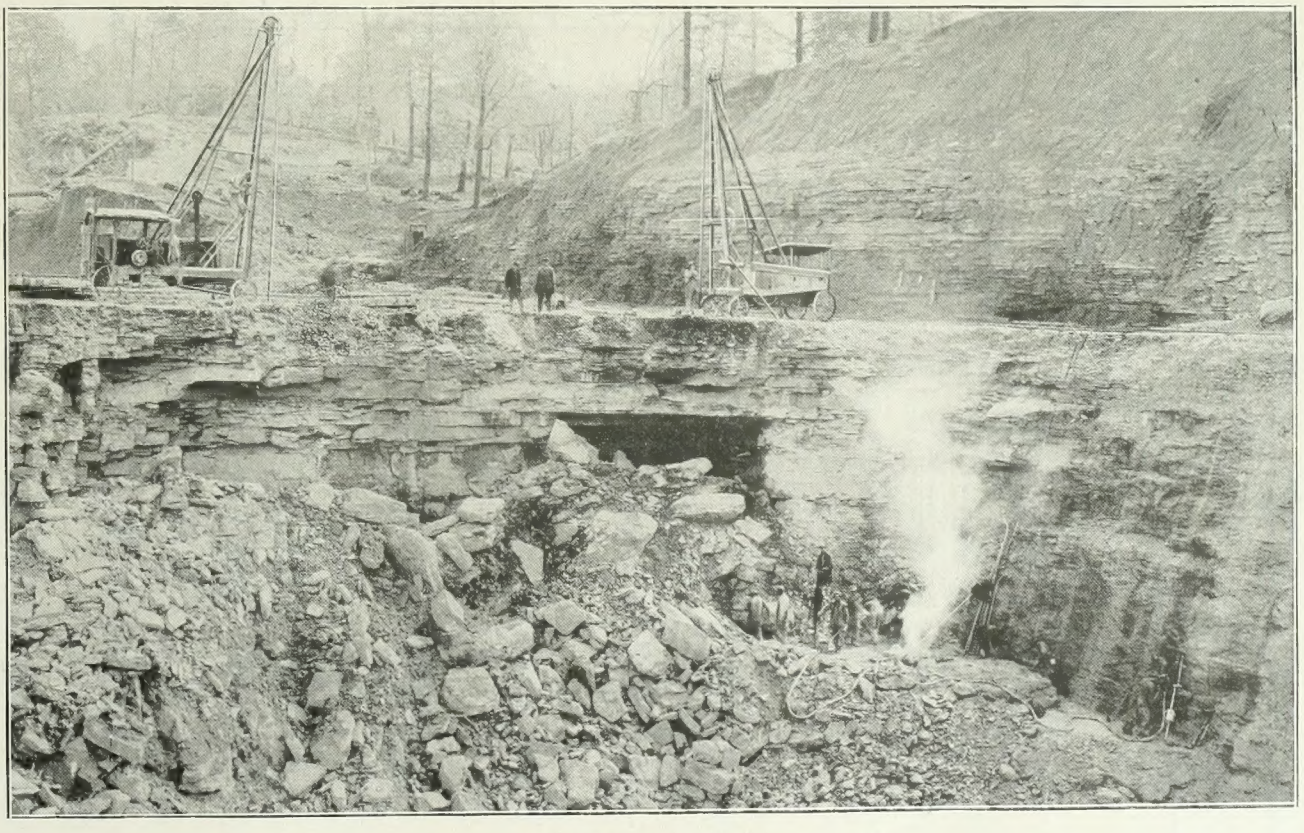
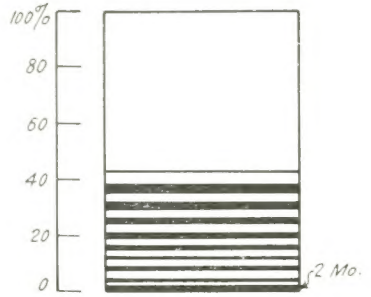


FIG. 70—DRILLING FOR ROCK EXCAVATION, TAYLORSVILLE DAM, MAY 13, 1919.

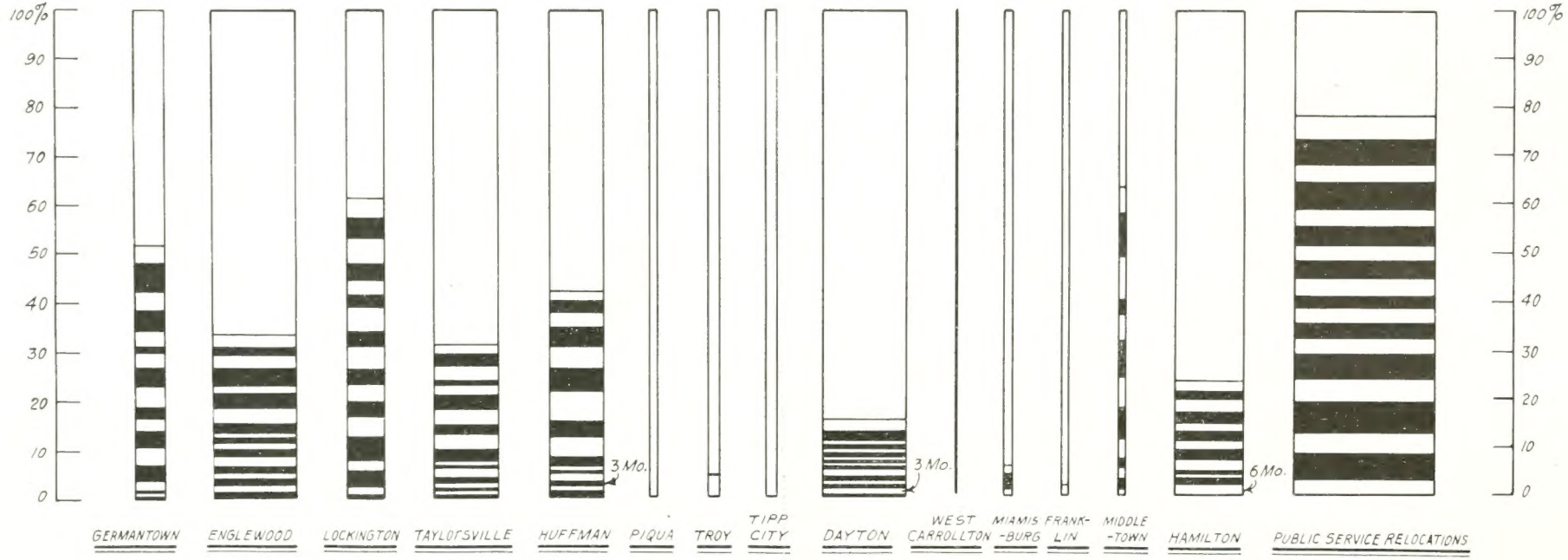


TOTAL WORK

Miami Conservancy District

PROGRESS DIAGRAM

Vertical Scale:- Percentage of Work Done
Horizontal Scale:- Relative Volumes of Work



WORK BY FEATURES

Note:-Each horizontal band, black or white, represents work of one month, unless otherwise noted

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THE

MIAMI CONSERVANCY BULLETIN

PUBLISHED BY THE MIAMI CONSERVANCY DISTRICT

DAYTON, OHIO

Volume 2 | January 1920 | Number 6

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"Therefore when we build, let us think we build forever. Let it not be for present delight, nor for present use alone. Let it be such work as our descendants will thank us for, and let us think as we lay stone on stone, that a time is to come when those stones will be held sacred because our hands have touched them and that men will say as they look upon the labor, and wrought substance of them, 'See this our fathers did for us.'"

—Ruskin.

Progress on the Conservancy Project

The diagram on the opposite page is designed to exhibit to the eye the exact status of the construction work on the project, up to October 1, 1919, the date to which it was shown in the last report of the Board of Directors to the Conservancy Court. The vertical block or rectangle over the words "Total Work" represents the entire work required to be done on the whole project. The portion of it striped in alternate black and white bands represents the fraction which had been completed on October first. The scale at the left of the rectangle is divided and marked so that the completed fraction can be estimated as a percentage of the whole, the bottom being marked "0," and the top "100%." Thus the top of the upper band, a white one, standing a little above the 40% mark, indicates that on October 1, 1919, the entire project was a little over 40% completed. (About 42%, to be more exact). Each horizontal band, whether black or white, represent the work of one month, unless otherwise noted on the chart. Thus the lower band on the "Total Work" rectangle is marked as representing two months' work.

The rectangles in the row below represent in a similar way the various "features" or divisions of the work. At the left are the five dams; then the nine divisions of the Miami River channel improvement; last, at the right, bunched in one broad rectangle, the public service relocations—the railways, roads, telephone and telegraph lines, etc., which had to be shifted to get them out of the water's way when floods fill the retarding basins. The bulk of this last, of course, is concerned with the four railways —the Big Four, Erie, Baltimore & Ohio, and Ohio Electric, totaling more than fifty miles of track.

The horizontal widths of the rectangles in the lower row differ in a way to show the comparative amounts of total work to be done on the different divisions. Thus the Englewood rectangle is a little over twice as wide as the Lockington rectangle, indicating a little over twice the amount of work on the Englewood dam when both are completed.

Exhibiting in this way the differences in total work in the various divisions, enables the reader to understand several things; as, for instance, why Germantown and Lockington are nearest completion of the five dams—they are the smallest and require least work. It explains how it was possible to

Table Showing Principal Quantities of Work Done

Flood Control Works Proper

	To Oct. 1, 1918	To Oct. 1, 1919
Earth removed from cut-off trenches and outlet works	274,680 cu. yds.	682,312 cu. yds.
Loose rock, hard pan, and solid rock removed from cut-off trenches and outlet works	64,535 " "	357,412 " "
Earth placed in dams	87,900 " "	1,504,012 " "
Earth placed in levees	55,800 " "	374,209 " "
Earth removed from river channels	47,190 " "	1,096,700 " "
Earth moved in soil stripping and in dressing slopes with earth	100,127 " "	158,437 " "
Earth moved in permanent road building	7,840 " "	41,437 " "
Earth moved in sewer construction	2,360 " "	18,720 " "
Concrete placed, exclusive of that in public service relocations	11,680 " "	104,945 " "
Clearing and grubbing	21 acres	80 acres
Steel placed	0 pounds	535,607 pounds

Public Service Relocations

	To Oct. 1, 1918	To Oct. 1, 1919
Earth excavation	193,500 cu. yds.	1,560,770 cu. yds.
Loose and solid rock excavation	270,500 " "	726,120 " "
Concrete placed in structures	8,500 " "	30,620 " "
Gravel placed on relocated roads	0 " "	21,900 " "
Steel re-enforcing placed	0 pounds	638,000 pounds
Track laid	0 miles	13.5 miles
Track ballast placed	0 cu. yds.	6,000 cu. yds.

finish the river improvement at West Carrollton so early—there was so little to do there, comparatively.

The public service (mostly railway) relocations are much the nearest done of any of the larger divisions of the work. The reason for this is clear. They had to be pushed first to get them out of the way of dam construction. And the dams are ahead of the river improvement, because the latter, as a means of flood protection, is rather less vital than the dams to the safety of the valley.

The table at the top of this page gives the items making up the completed 42% of the total work, as indicated on the chart. The right-hand column, like the chart, carries the estimate to October 1, 1919. The left-hand column carries it to October 1, 1918. The difference between the two, for any item, represents one year's progress. The figures should give renewed assurance to all the friends of the project that the work, considering especially the unusually difficult circumstances produced by the war, under which it was begun, is proceeding at a rate which should finish it within the estimated time.

The table below is also from the last report of the Board of Directors to the Conservancy Court, and exhibits the financial condition of the project up to July 31, 1919.

Condensed Summary of the Net Cash Receipts and Disbursements, August 12, 1915, to July 31, 1919.

	Aug. 12, 1915 to July 31, 1918	Aug. 1, 1918 to July 31, 1919	Totals Aug. 12, 1915 to July 31, 1919
Net Cash Receipts			
Sale of Bonds (Net)	$14,400,000.00	$5,194,900.00	$19,594,900.00
Taxes Collected		1,275,028.01	1,275,028.01
Assessments Paid in Advance	759,268.94	4,821.71	764,090.65
Interest Earned	175,939.41	135,187.48	311,126.89
Sale of Real Estate		113,713.45	113,713.45
Real Estate Operation Receipts	40,221.89	223,122.38	263,344.27
Engineering Department Receipts	644.74	146,440.49	147,085.23
Miscellaneous Receipts	3,340.34	4,569.86	7,910.20
Accounts and Notes Receivable	2,221.54	146,022.75	148,244.29
Total Net Cash Receipts	$15,381,636.86	$7,243,806.13	$22,625,442.99
Net Cash Disbursements			
Interest on Bonds	$ 413,325.00	$ 961,675.00	$ 1,375,000.00
Interest on Loans	40,241.00		40,241.00
Office Building	16,934.05	157.82	17,091.87
Osborn Business Claims	73,015.00	50,157.50	123,172.50
Miscellaneous Items	2,377.17	6,350.29	8,727.46
Administrative Department	97,087.90	72,946.62	170,034.52
Legal Department	208,789.74	94,617.40	303,407.14
Taxation Department	175,293.18	30,028.72	205,321.90
Real Estate Investments	6,460,765.14	824,781.85	7,285,546.99
Real Estate Operations	38,217.42	129,408.79	167,626.21
Crop Operations, Etc.	27,311.50	15,321.81	42,633.31
General Expense	24,282.07	80,955.47	105,237.54
Engineering and Construction	3,418,471.84	6,629,346.57	10,047,818.41
Total Net Cash Disbursements	$10,996,111.01	$8,895,747.84	$19,891,858.85
Balance on Hand, July 31, 1919			$ 2,733,584.14

Geology of the Miami Valley as Affecting Conservancy Work

Careful Study Made of Rock Occurrence and of Glacial Drift as Dam Embankment Material.

The rock occurrence in the Conservancy District affected the work of construction in two different ways. In one, the Conservancy engineers sought the rock to secure solid foundation for the concrete outlet structures which will carry the stream flow under the completed dams. In the other they would avoid the rock if they could, this case being the relocation of the railway lines necessary to take the old tracks out of the way of the dam structures. With five dams to be built and four railways to be relocated, the necessities for finding or avoiding rock required rather thorough preliminary study of the geology of rock occurrence throughout the Miami Valley. In relation to the proper materials of which the dams were to be built, a study of the glacial drift which fills the valley was of no less importance.

All the streams of the region wind through broad, flat valleys enclosed between slopes rising upwards of a hundred feet above the valley bottom. Between the valleys the country is gently rolling. The entire region is covered with soil varying from a foot or two to hundreds of feet in thickness, practically all of which was brought down and deposited by the enormous ice sheets which slid down out of Canada in a former geological time. These glaciers plowed off the hill tops, and deposited the material farther south, filling valleys in places hundreds of feet deep. The rock on higher ground, where the soil is thin, still bears in many places the rude autography of the glacier, in the shape of parallel scratches graved by granite boulders or pebbles held firmly in the clutch of the dry ice as it slid over the surface. The pre-glacial valleys, while sometimes coincident with the valleys of today, were much deeper, dug out by streams during the lapse of possibly millions of years, only to be partially filled by the glaciers, leaving the much shallower but broader valleys of today, in which the present river courses are now in process of being carved.

The entire country, valley and upland, is underlaid with limestone belonging to two geological periods, the lower being the Ordovician, the upper the Silurian. The Ordovician in the Miami Valley all belongs to the so-called Cincinnatian formation, occurring in rather thin layers interstratified with sheets of shale. The Silurian limestones are much more solid, with the strata usually considerably thicker, and are frequently of use either for building stone (as the Brassfield, Dayton, and Springfield) for cement, (Brassfield) or for burning into lime (Cedarville). The Cincinnatian formation is not used for either of these purposes.

The pre-glacial streams of the Miami Valley cut their way successively through all these layers of limestone, from the topmost, the Monroe, down through the Cedarville, Springfield, Orgood, Dayton, and Brassfield (the Silurian group) then through the Richmond, Maysville and Eden, (the Ordovician group, the latter all comprised in the Cincinnatian formation.)

The melting of the glaciers evidently resulted in streams considerably larger than those of the present day. The material left by the ice in the deep pre-glacial valleys was worked over by the water and left in beds of gravel, sand or clay. In the middle of the valleys this material may be hundreds of feet deep, while on the sides the underlying rock approaches much nearer the surface crust and in places is even exposed. That is, valleys which were deep canyons, 300 or 400 feet deep, have been filled up until now they are 50 to 100 feet deep, with a broad, flat bottom. Over this surface there has been deposited by later overflow a layer from one to 10 or more feet in thickness, of clay or modified till; that is, earth and rock ground up by the glacial action.

It was the great

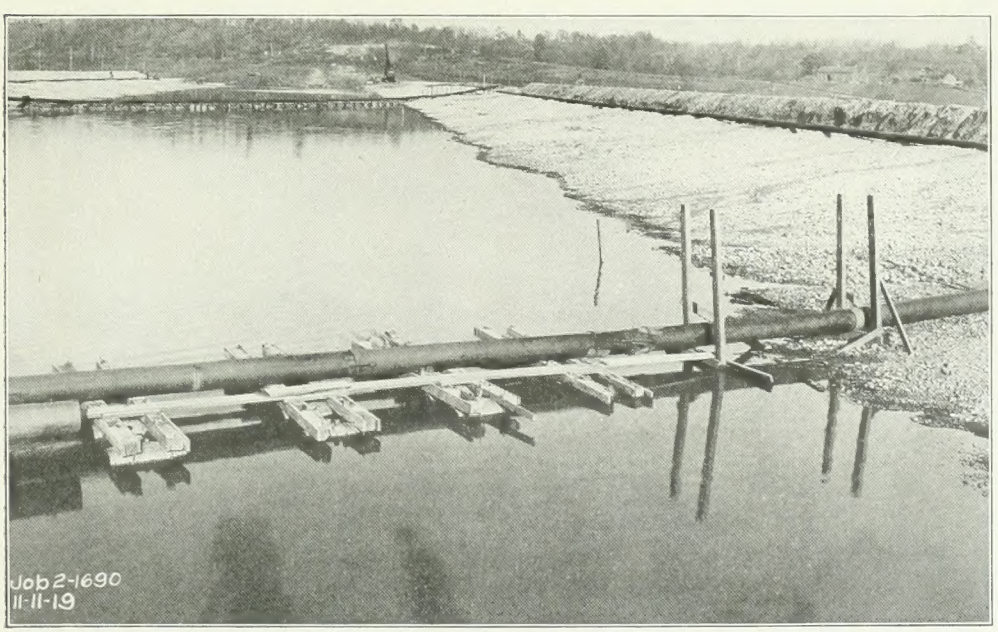

FIG. 72—SHORE LINE, HYDRAULIC FILL POOL, ENGLEWOOD DAM.
The material, mixed earth and water, is pumped through the two pipe lines seen, (coming from the "hog box," out of the picture at the left), and is discharged at the edge of the long bank at the right. The gravel and coarse sand are deposited on the sloping beach. The fine material is carried on into the pool, and settles to the bottom. This settling is very slow, on account of the fineness of the suspended material. A 6-inch cannon ball, dropped over the edge of a boat on the center line of the pool, will sink first through water, then through very thin mud, then through a thicker and thicker mud, till about 17 feet below the surface (in the pool as seen), it will come to rest. Taken Nov. 11, 1919. (See also Taylorsville Progress Report, p. 86.)

depth of the glacial drift in the valleys of the District which determined the materials of which the Conservancy dams are being built. If the earth cover had been shallow, permitting masonry foundations to be sunk to bed rock across the valley at reasonable expense, perhaps concrete might have been chosen as the building material. But with bed rock hundreds of feet below the present valley bottoms this was out of the question. Therefore the earth dam, the only alternative safe type, was adopted.

The combination of superficial layers of clay material in the glacial till, with subsurface deposits of sand and gravel more or less sorted by water, make the valley material nearly ideal for the construction of earth dams by the hydraulic fill method. The glacial till furnishes the impervious material for the dam core. The sands and gravels beneath furnish stable materials necessary for the outer slopes. By varying the amounts of material taken from the surface and the subsurface depths, the ratio of core thickness to the thickness of the dam slopes can be altered, so that the necessary combination of imperviousness with stability can be obtained in the dam structure. (See pages 188 and 189, Bulletin for July, 1919, for description of hydraulic fill method.)

There remained the problem of obtaining suitable foundations for the concrete conduits which must carry the stream flow underneath the structure of the dam. These structures are subject to severe conditions. In times of maximum flood they must carry thousands of tons of water per second at high speeds, at Englewood 60 feet or more per second, with possible tendency to vibration, the maximum head at Englewood being over a hundred feet. The foundations must, therefore, be of assured stability. Also, the conduits must be located at an elevation such as to carry the stream flow through the base of the dam at its present ordinary level. The proper outlet location for a Conservancy dam, therefore, would be at a point just far enough up the old pre-glacial valley slope to reach solid foundations in the rock at the necessary level without unnecessary expense for either rock or earth excavation. The principal features at the various dams, both of the location and of the methods of taking out the rock, appear in the article on rock excavation. (See page 89.)

November Progress on the Work

GERMANTOWN

The hydraulic fill has progressed favorably, 55,400 cubic yards being pumped during November. This brings the total amount of material placed at the end of November to 323,500 cubic yards, which is approximately 40 per cent of the total hydraulic embankment to be placed. The embankment has been carried to elevation 765, or approximately 45 feet above the old creek bed.

Paving the upstream slope of the dam with the oversize rock from the pumping plant has made favorable progress during the past month.

Progress on the spillway has been satisfactory, the total quantity excavated, to the end of November, being 12,000 cubic yards.

Arthur L. Pauls, Division Engineer.

December 15, 1919.

ENGLEWOOD

During the month of November 103,160 cubic yards of material were pumped into the dam, bringing the total embankment to 943,000 cubic yards. On December 15, the estimates show that the one-million mark was reached. As the placing of embankment did not begin in earnest until April, this progress is probably a world's record for the construction of earth dams. To date the embankment is slightly more than 29 per cent completed.

The two cross dams, for the purpose of confining at the ends the hydraulic fill, have been completed.

Work on Sump No. 2 is progressing favorably. The excavation is completed and concreting for the pump foundations, pump house, etc., has begun.

H. S. R. McCurdy, Division Engineer.

December 15, 1919.

LOCKINGTON

During the recent cold weather pumping of the hydraulic fill was carried on twenty-four hours a day to keep the water pipes and ditches from freezing. On December 10, the sudden drop in temperature made it impossible to proceed, and since then only two shifts have been pumped. The greatest difficulty that was experienced was from freezing of the open ditch leading sluice water from the Miami and Erie Canal to the borrow pit. To date there have been placed in the dam 195,000 cubic yards of hydraulic fill, over 80 per cent of which was placed since September 1. Surfacing the slopes of the dam with rock is being continued as a part of the winter program.

The large Lidgerwood (class D) dragline placed in the west 3400 feet of the dam 100,000 cubic yards, making a total of 392,000 cubic yards placed in the dam embankment.

The Lidgerwood Class K dragline has completed its work at Lockington, having moved a total of 500,000 cubic yards of earth. The steam dragline aided in dismantling the larger machine and loading it onto cars for shipment to Dayton. The steam machine will be put into thorough repair this winter to be ready for its work on the dam next spring, consisting principally of excavating the deep portion of the cut-off trench east of the outlet structure.

Barton M. Jones, Division Engineer.

December 20, 1919.

TAYLORSVILLE

The Lidgerwood Dragline was shut down for seven shifts on account of a break in the center casting, but in spite of this delay, the progress for the month was but slightly below the schedule set for this work. The excavation for that part of the outlet and inlet channels which is to be lined with concrete will be completed about Mar. 1.

The placing of concrete in the outlet works has progressed very satisfactorily at such times as gravel could be had. For some time the B. & O. R. R. Relocation has had first claim on the output of our gravel pit, and gravel for the concrete plant could only be furnished at such times as there happened to be a delay in the railroad work. The delivery of gravel for ballast to the B. & O. Relocation is practically completed, so that there is not likely to be any more delay on this account.

Some tests recently made with a 6-inch cast iron ball in the hydraulic fill core may be of interest. The ball was dropped into the pool at station 18 on the center line of the dam. At the end of one minute it had sunk to a depth of 6.5 feet below the water surface, which at that time, was about 0.3 feet above surface of mud. At the end of twenty-five hours it had reached a depth of 6.87 feet. In 50 hours, 7.05 feet, one week 7.05, and at the end of four weeks 7.18 feet.

O. N. Floyd, Division Engineer.

December 16, 1919.

HUFFMAN

The hydraulic fill has been progressing during the past month. The work, however, has been hindered somewhat on account of unfavorable weather conditions. 47,300 cubic yards of material were pumped during the month of November.

The steam dragline has built the outside levees up to the first berm, on both sides of the dam between the diversion channel and the Erie Railroad. A cross dam ten feet high has been built along the south side of the pres-

ent location of the Erie track so that the embankment may proceed without waiting until the track has been moved to its new location.

The delivery of the ballast gravel for the relocated road bed of the Big Four and Erie Railroads was begun on December 8th. This gravel is being excavated with the electric dragline in the borrow pit above the dam, loaded into cars and delivered to a point on the relocated line, where it is taken by the Walsh Construction Company, who have the contract for placing the ballast in place.

The main excavation and fill for the relocation of the Valley Pike have been completed and Contractor McCann has removed his steam shovel to other work. The excavation of the side ditches and the placing of the rolled gravel surface probably cannot be completed until more favorable weather in the spring.

C. C. Chambers, Division Engineer.

December 19, 1919.

DAYTON

Channel excavation to date amounts to 666,300 cubic yards. The total pay quantity placed in levees and spoil banks is 467,500 cubic yards, including 60,000 cubic yards of levee embankment on Contract No. 41. In accomplishing this work a total of 1,171,900 cubic yards has been handled, not including excess depth channels. During the night of December 8, the temporary dam at Sunset Avenue washed out. This occurred about two weeks before it was intended to remove the structure and will necessitate taking all the 30,000 cubic yards of excavation remaining above the dam to Sunrise Avenue spoil bank, instead of hauling a portion of it to the Stillwater Avenue Spoil bank.

The large dragline D16-15 is grading the downstream end of the spoil bank below Herman Avenue on the west side of the river. D16-16, the other large dragline, is moving off its scow and will continue excavating above Third Street, working on a roller mounting. The Class 9½ caterpillar dragline is grading the top of the spoil bank between Herman Avenue and Webster Street.

The Lidgerwood Class K dragline, D16-8, has been shipped from Lockington and some parts have arrived in Dayton. It will be erected near the gravel washing plant at Sunrise Avenue.

Work on the concrete revetment has been suspended because of cold weather. About 550 cubic yards of concrete have been placed in the South Robert Boulevard Wall. Apparatus for heating the gravel plant is being installed in order to permit operation during the cold weather.

C. A. Bock, Division Engineer.

December 16, 1919.

HAMILTON

The total yardage handled to December 1 was 975,000 cubic yards. The pay quantity was 516,900 cubic yards.

The electric dragline has taken out the temporary railroad embankment south of the Columbia bridge, built for construction purposes, which remained from the last cut, and is at present moving around the east end of the bridge to get into position for the second cut north of the bridge.

The steam dragline has been at work on the Old River channel west of the B. & O. R. R.

Excavation has been completed for the two branches of the tail race under the B. & O. R. R. bridge, and concreting has been completed under the south arch. The concrete floor has been poured under the north arch.

On the retaining wall work on the east bank just south of the Soldiers' Monument the excavation and pile driving have been completed. The forms for the footing have been built and the reinforcing steel is in place ready for the concrete.

The portable gravel screening plant has been placed in operation.

The brick paving has been removed from that part of

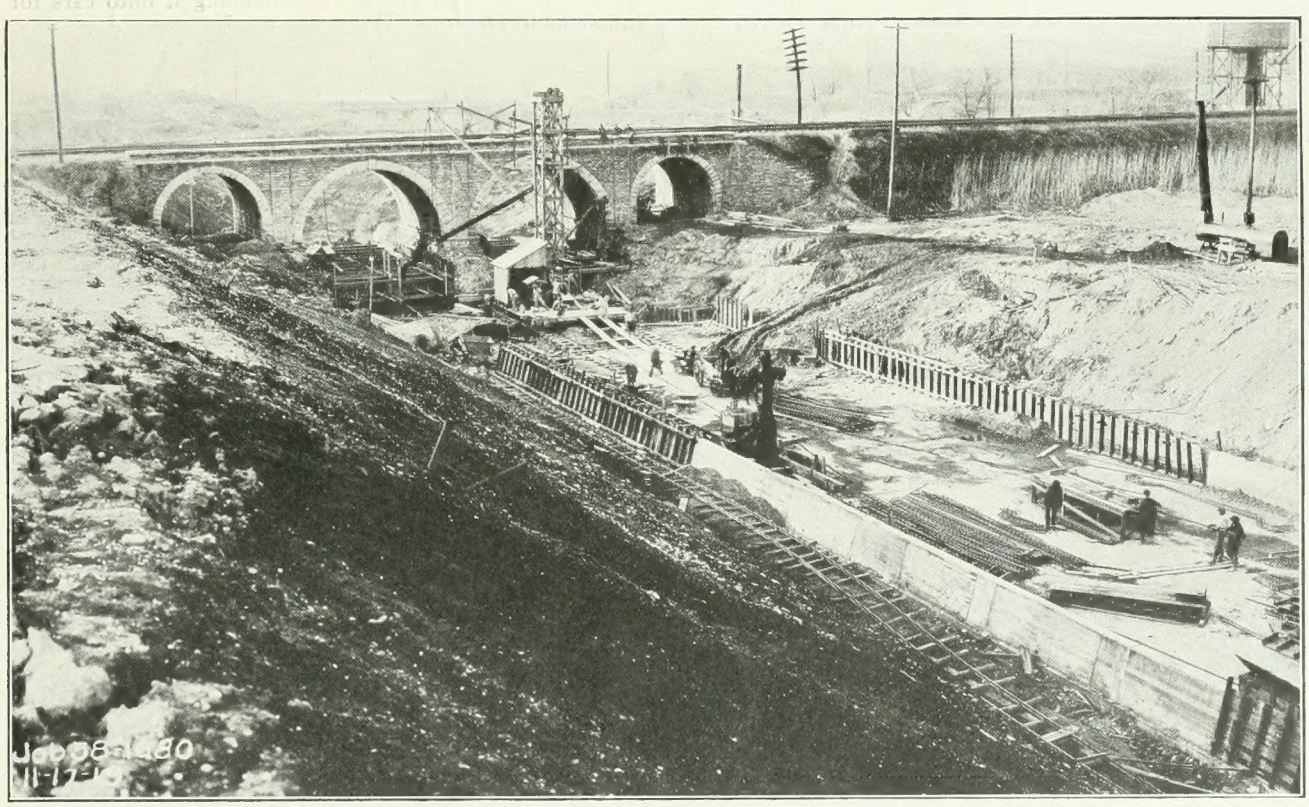

FIG. 73—BUILDING TAILRACE UNDER B. & O. R. R. BRIDGE, HAMILTON, NOV. 17, 1919.

This is a view of the Ford power house tailrace, taken from the top of the tractor plant. (See Fig. 68, in Bulletin for December, 1919). The tail water from wheels aggregating 3500 horsepower will flow between the two low concrete walls, seen finished in the foreground at the right. At the B. & O. R. R. bridge the race divides, a branch carrying half the water under each of the two middle arches. The tower enables fresh concrete to be poured from one point for both walls of both branches. The extra expense for this tailrace is borne by the Ford Company. The bank of earth in the left foreground is the north protection levee of Hamilton.

North Third Street which will be raised for the levee crossing.

C. H. Eiffert, Division Engineer.

December 20, 1919.

TROY

Work was continued by the dragline on the cutoff channel. Approximately 35,000 yards were excavated from the channel, of which about 3,000 yards were placed in the levee. On account of unfavorable weather, it was decided by McGillicuddy & Co. to shut down for the winter. Excavation was therefore discontinued on December 19, and after the two stormwater outlets through the levee are completed, no further work will be done on the Troy improvement until spring.

E. W. Lane, Assistant Engineer.

December 20, 1919.

LOWER RIVER WORK

Miamisburg. The levee adjacent to the B. & O. R. R. above Germantown Pike has reached approximately the full width at the base. The spur track from the B. & O. R. R. to the J. C. Groendyke Twine Factory has been raised a maximum of 10 feet at the point where it will cross the proposed levee. Rain and high water caused considerable delay during the past month.

Franklin. The levee from the C. & N. R. R. to the point where it crosses Oxford Road, about 200 feet long, has been completed and sod from the water works lawn placed on the side slopes. From this point north about 300 feet of the levee is finished with the exception of top dressing. The raising of Oxford Road to extend over the levee is nearly finished. The work has been practically at a standstill since December 2, owing to a breakdown of the dragline excavator.

Middletown. The levee south of the Verity Golf grounds has been completed to a point about opposite Seventh Street. Three hundred feet north of this point, rock was found near the ground surface in the borrow pit. This necessitates widening the pit considerably in order to get sufficient material to build the levee. This again necessitates moving a large quantity of the material twice. Since the high water of November 30 the pit material has been so wet that it is very difficult to handle the second time. Cole Brothers have moved the machine therefore to a point north of Eleventh Street, where there is sufficient material above the rock to build the levee with one throw of the machine. It is hoped that when the river returns to normal stage the water in the upper borrow pit will drain sufficiently to allow work to continue unhindered.

F. G. Blackwell, Assistant Engineer.

December 16, 1919.

RAILWAY RELOCATION

Big Four and Erie. All grading on these two railways is now completed. The Walsh Construction Company are clearing the right-of-way and tearing up the construction tracks. About twenty miles of track has been laid and a portion of the Fairfield yard track completed. The Walsh Construction Company started the ballasting, but were forced to stop on account of cold weather. Progress has been delayed on this account and by scarcity of labor.

The concrete highway bridge at Huffman is about 80 per cent completed. This is being constructed by the District's own forces.

The Big Four Railway signal gang at Fairfield has completed the foundation for the interlocking tower and is now working on the pipe carriers.

The foundation for the Tate's Point interlocking tower is completed. The brick for the structure is delivered, as well as all signal material. Funderberg Brothers have

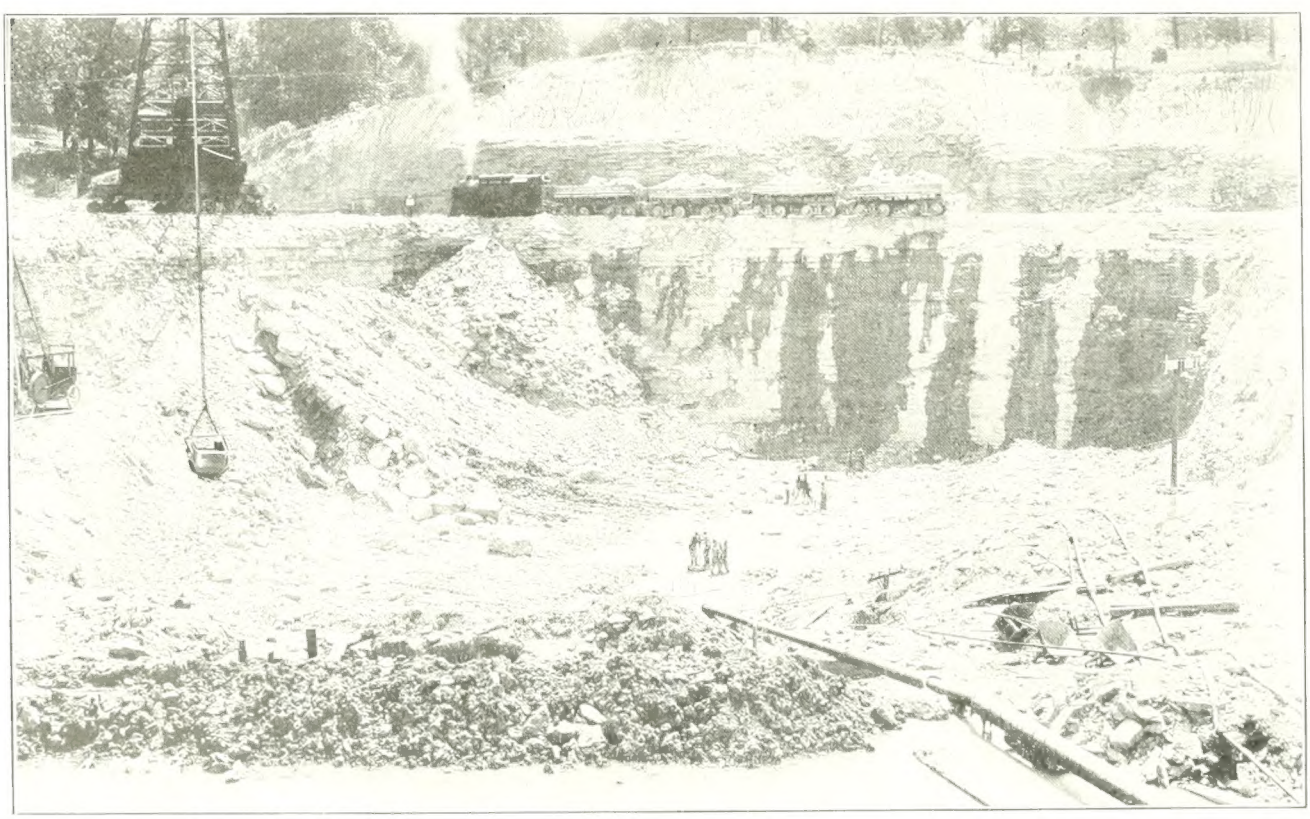

FIG. 74—LOOKING ACROSS THE OUTLET WORKS EXCAVATION, TAYLORSVILLE DAM, JULY 9, 1919.

Shows dragline machine (seen in part at left) near the finish of its record performance, excavating rock from the bottom of the cut, 63 feet below the rock shelf on which the machine and dump car train are standing. The maximum cut, bottom of pit to top of earth bank, is 100 feet, of which 77 feet is in rock. The machine thus reached material 37 feet above the rock shelf, as well as 63 feet below it, an excellent illustration of the great flexibility of this type of excavator. A similar machine at Huffman excavated the entire width of the cut there (174 feet bottom width) from the trench center line, showing also the remarkable reach of these machines. It was this unusual flexibility of the dragline which led to its adoption for the outlet works excavations at the Conservancy dams.

completed about 25 miles of right-of-way fence to date.

Ohio Electric Railway. All the steel rails have arrived and some of the ties have been unloaded at Fairfield. Work will not be resumed on this line until tracklaying is completed on the Big Four and Erie Railways.

Baltimore & Ohio. The work on this line has been suspended on account of cold weather. The ballasting is about 85 per cent completed. The raising of the track south of Needmore Road, which the railroad is doing with its own forces, is nearly completed.

The fencing on this line has recently been completed by H. W. Miller, sub-contractor for H. C. Kahl.

Albert Larsen, Division Engineer.

December 20, 1919.

RIVER AND WEATHER CONDITIONS

The river and weather conditions during the month of November were not greatly different from normal. During the first week the rivers were a little higher than usual, for this time of the year, due to the rainfall of October 25 to 31. A small rise also occurred during the last week due to the rainfall of November 25 to 29.

The total rainfall during the month at the District's stations varied from 2.84 inches at Fort Loramie to 4.95 inches at the Englewood Dam. The maximum 24-hour rainfall occurred on November 29, varying from 0.60 inches at Pleasant Hill to 1.46 inches at Ingomar. At the Dayton Weather Bureau Station the total for the month amounted to 3.23 inches, or .34 inches greater than normal, bringing the accumulated excess since January 1 up to 2.26 inches.

Observations taken by the local office of the U. S. Weather Bureau at Dayton showed that at Dayton the mean temperature for the month was 41.9 degrees, or 0.4 of a degree less than normal; that there were 11 clear days, 8 partly cloudy days, 11 cloudy days, and 16 days on which the precipitation amounted to or exceeded 0.01 of an inch; that the average wind velocity was 11.6 miles per hour, the prevailing direction being from the southwest; and that the maximum wind velocity for five minutes was 56 miles per hour from the southwest on the 29th.

Ivan E. Houk, District Forecaster.

January 5, 1919.

Rock Excavation at the Conservancy Dams

Depth and Width of the Excavations, and Depth Below Low Water Level, Led to Adoption of Dragline Excavators for the Work.

As stated in the preceding article, the rock excavation at the dams was for the purpose of securing stable foundations for the concrete conduit and outlet structures. At all the dams except Lockington the rock was of the Cincinnatian formation. This consists of alternating layers of limestone and shale, the limestone occurring usually in layers varying from a fraction of an inch to five or six inches in thickness. At Taylorsville a few strata were encountered which blasted out in rather massive blocks, three to five feet in thickness, but these blocks proved to be made up of several layers of limestone, of more than normal thickness, running up to 13 inches, cemented firmly together by ⅛ inch to ¼ inch layers of shale. At Englewood the layers of limestone and shale are distinct, the limestone coming out in hard slabs. At Taylorsville the two kinds of rock are blended or mixed. At Germantown the proportion of limestone to shale is small. The Cincinnatian occurs exposed to the surface, or covered with a blanket, usually of glacial till, varying from a foot or two to 20 feet thick. Within six to ten feet of the ground surface, the Cincinnatian rock is weathered and the shale layers rotted by the action of air, water and frost to such an extent that it is removable without blasting. Below this depth, drilling and blasting with dynamite were necessary.

The method of excavation adopted was prescribed by the conditions encountered. These conditions varied considerably at the different dams, but certain features were common. The cuts were all of considerable length, running up to a maximum of 1850 feet; and of considerable depth, the maximum at Taylorsville being 100 feet, 77 of which was in rock. All had a width for the conduits proper much narrower than for the corresponding entrance and exit channels. And finally, the cuts were all carried a considerable depth below mean low water level, the maximum being 38 feet and the minimum about 22 feet.

Practically, under these conditions, the choice as to means lay between steam shovels and dragline excavators. In general, the steam shovel can load, swing, and dump considerably quicker than the dragline. Also steam shovels of a powerful type have been developed particularly adapted to heavy rock excavation. Nevertheless, and in spite of the advantages mentioned, dragline excavators were chosen for the work.

There were several reasons for this. The first was that with such excavations as have been described, a steamshovel would be obliged to make a "thorough cut," taking the material out in several lifts, and working from end to end of the excavation in removing each lift. Thus, before concreting could begin, a large proportion of the excavation would have to be completed.

This is not true of the dragline excavator. The latter machine has a great advantage over the steam shovel in the depth, height, and breadth of its reach. Excepting at Taylorsville, a case to be considered later, a dragline machine could work down the center line of any of the conduit excavations, and at one journey clean up the job, removing all the material as it went. It could begin at one end and as soon as it had cleaned up the first forty or fifty feet of its task, the concreting could begin immediately behind it, and follow it up without any delay. With the necessity of beginning the work of concreting at the earliest possible moment, this was a very great advantage.

Another was the less danger to dragline equipment in case of flood during the work of construction. A steam shovel is compelled to get under the material which it excavates; to do this it must go to the bottom of the cut, since it can reach with its dipper but a few feet below the level of the track on which it stands.* Required thus to go far below mean low water level, a steam shovel caught at the bottom in case of a flood which should overtop its protecting earth cofferdam, might be "drowned out" like a gopher in its hole.

* It is true, special shovels are designed which will work a considerable distance below track level, and in fact steam shovels of such a special design were considered for the work, but their other limitations prevented their adoption.

A dragline excavator, on the other hand, does not need to get down into the hole it excavates. It can reach down with its bucket. (At Taylorsville it reached 63 feet below the rock shelf on which it stood, a record performance of the kind in rock excavation). Thus, both the dragline machine and the locomotives and dump car trains which take away the excavated rock, can stand at a comparatively high elevation, reasonably safe from flood. §

A connected difficulty would arise from the fact that a steam shovel cannot dump its dipper at a level very far above the steam shovel track. This would mean that the cars to be loaded must go down with the steam shovel into the excavation, to depths which would make it difficult to get the loaded trains out. This was perhaps the preponderating count in favor of the dragline excavator for the work in view.

A further advantage of the dragline is that it requires less labor to run the equipment. This is because, on account of its much wider reach, it requires less track shifting. It would save, as compared with a steam shovel, the expense of a track gang of six or seven men at each dam. What was of more importance, during the emergency labor shortage of war time, when the work began, it would release these men for war work.

Finally, the dragline had the advantage that it could adapt itself easily to the varying breadth of the excavation, drawing in for the narrow width of the conduit proper, and reaching out when at work in the wider inlet and outlet.

Consideration of all these points left no doubt as to which was the proper equipment to use.

Englewood and Germantown

The general conditions at these two dams were much the same. The excavation in each case was a long, deep trench, 30 to 32 feet in the bottom width, and widening to over 100 feet at the ends. The work was done at one trip of the dragline in each case, beginning at the outlet end. The top 7 to 10 feet, including much loose rock, was first removed. Drills were then set up back of the dragline and holes sunk to an average depth on the center line of 18 feet at Germantown and 28 feet at Englewood. After blasting with 40 per cent dynamite the loosened material was picked up with the dragline bucket, dumped into 12-yard air-dump cars and taken by 40-ton locomotives to a spoil bank where the material was wasted. The total rock thus removed at Germantown was 40,000 cubic yards, the work there beginning about August 1, 1918, and ending in March, 1919. At Englewood the work began May 10, 1918, and ended November 9 of the same year, the total rock removed being 57,712 cubic yards. Not all of the material at Englewood was wasted, a considerable quantity being placed next the down stream toe of the dam to serve as a protection against eddies below the outlet during floods, which might tend to wash away the earth of the dam structure. At Germantown 30,400 pounds

§ It is an interesting circumstance that contractors who were consulted at an early date in the formulation of the construction program, declared that at such depths as would be encountered at the Conservancy dams, a dragline bucket would not pick up the material, but would bump and tumble over the heap of blasted rock without digging in.

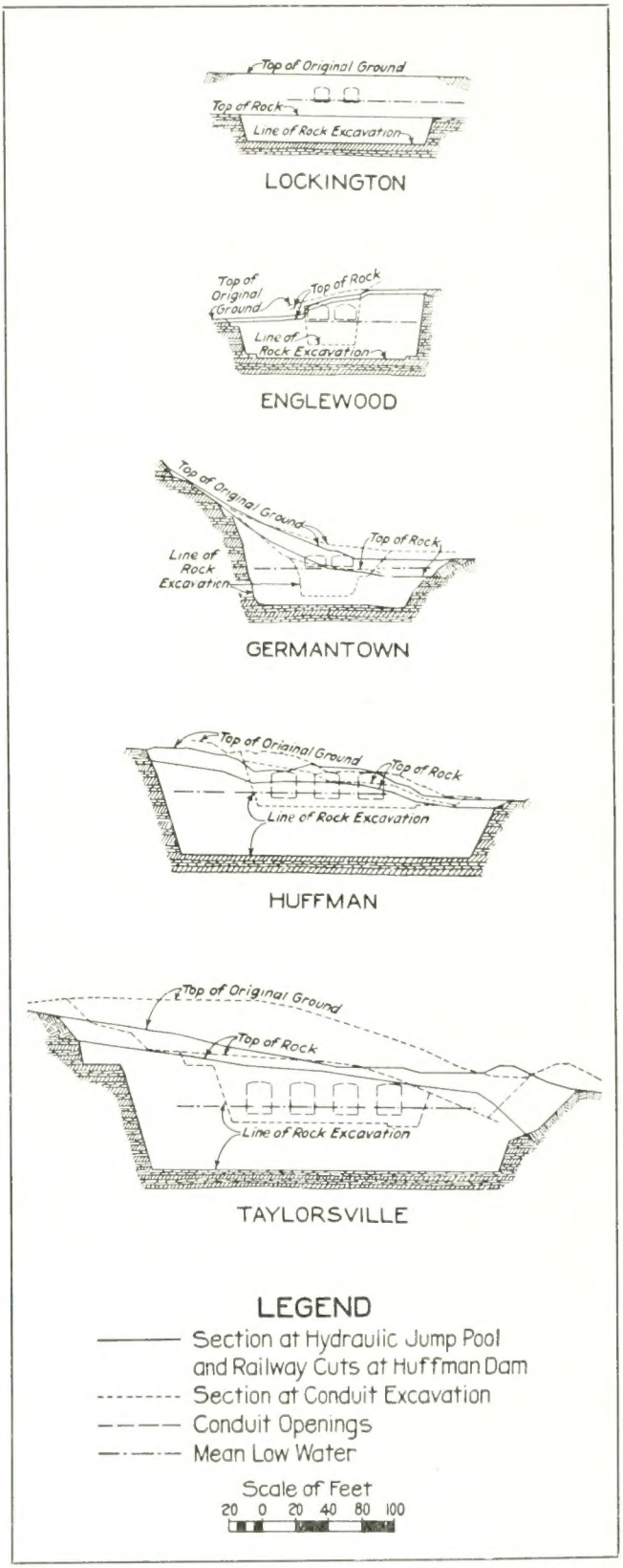

FIG. 75—SECTIONS OF OUTLET EXCAVATIONS.

Shows this work at all the dams, drawn to the same scale. The dotted sections are taken at the conduits proper; the full line sections are taken at the conduit outlets (at the hydraulic jump pool). The openings (in dashed lines) are the conduit openings as they will be when finished. All sections are shown looking downstream. At Lockington practically no excavation, (except a small amount for the pool), was necessary.

of dynamite was used, practically three-fourths of a pound per cubic yard excavated. At Englewood the amount used was one-half pound per cubic yard. The drills were tripod drills using steam. To trim the sides and bottom and cut out the corners small compressed air "Jap" drills were employed. At Germantown this trimming was kept within reach of the dragline bucket, which was thus able to remove the loosened material. At Englewood the trimmings were thrown by hand into skips or dump boxes which were lifted out of the excavation by a locomotive crane. The final dressing of the side walls and bottom was done with picks, and very carefully, in order to make sure that all loose rock should be removed and a solid surface presented for the concrete of the conduit.

Huffman

The conditions here were somewhat different from those at Englewood and Germantown. The flood flow provided for at the dam is so great as to require three conduit openings instead of two, necessitating a much greater width of structure. Also the topography and other conditions required that the excavation be carried to a much greater depth. The maximum width at the outlet was 174 feet, and the maximum depth, from the loading track to the bottom of the excavation, was 64 feet. The maximum depth of the rock cut was 60 feet.

The method followed was in general similar to that at Englewood and Germantown. The dragline excavator ran down the approximate center line of the conduits, from which it was able to reach all the material, even to the maximum width of 174 feet. The depth of the cut, however, was such that the machine (a class 24 Electric Bucyrus Dragline with 100-foot boom and 4½-yard bucket) could more efficiently take the material out by making two trips. The material was drilled and blasted in three layers, each about 20 feet thick, this thickness being exceeded in the deepest places in the lower lift in order to reach the bottom. The dragline cleaned away the upper layer on its first trip and all the remaining material on the second. In the deepest place the blasted material was picked up by the dragline bucket at a depth of 64 feet below the loading track, and 58 feet below the level of the ground upon which the machine stood. This at the time was a record performance for deep excavation by such a machine in rock material. (It was exceeded a little later by the machine at Taylorsville). The Huffman dragline excavated a total of 25,000 cubic yards from one position in the course of this work, which is believed to be also a record dragline performance.

Most of the holes were sunk by a well drill and a wagon drill. The well drill averaged 45 feet of hole per day at a cost (not including overhead), of $0.27 per foot. The wagon drill did a maximum of 240 feet in one day. The trimming of sides and bottom, as at Englewood and Germantown, was done with "Jap" drills. All the work of drilling and blasting was kept well out of the way of the excavation, the dragline suffering no delays at any time from this cause. The total amount of dynamite used at Huffman was 70,000 pounds. The total amount of rock excavation was 39,500 cubic yards, giving a figure of 0.52 pounds per cubic yard.

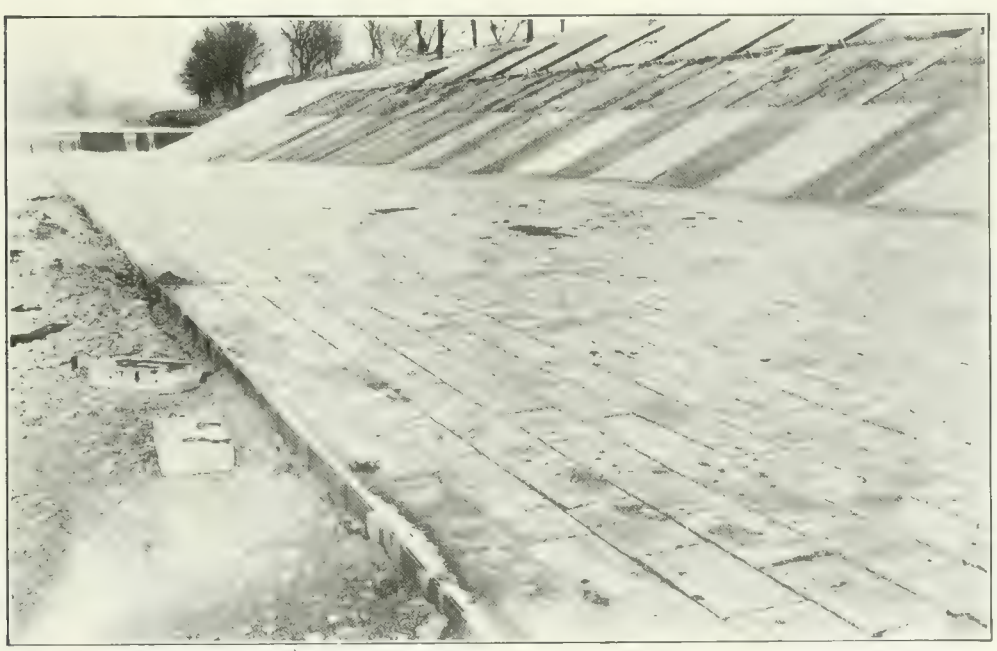

FIG. 76—CONCRETE REVETMENT, MIAMI RIVER AT DAYTON, DEC. 29, 1919.

The revetment on the slope of the levee, (2:1 slope,) is of 6-inch reinforced concrete slabs built in alternate blocks as seen. At the foot of this slope is a low sunken concrete wall or footing capping a row of piles driven 8 feet in the ground, 3 feet apart. From this wall the "flexible revetment" extends, (lying on the very flat slope of the river bed as seen), about 30 feet toward the center of the channel. It is made of concrete blocks, 1 foot by 2 feet in size, woven into a "mattress" by galvanized steel cables, anchored in the sunken wall mentioned, and in a heavy concrete "footing" at the other (left) edge, and passing through holes cast through the blocks. (See Bulletin for August, 1919, page 13).

Lockington

The conditions of rock occurrence at Lockington were quite different from those at any other dam. The rock is not of the Cincinnatian formation, but of the Silurian, a later period, comprising rocks of the Springfield, Dayton and Osgood series. The layers are all of hard limestone, from 4 inches to 18 inches thick and practically level, the dip, which is to the north, being imperceptable except to measurement. The material is also much firmer than that of the Cincinnatian formation, permitting its use as plum stones in the concrete or as rip-rap on the slope of the outlet channel below the dam.

The outlet location was selected a few hundred feet east of Loramie Creek, where bed

rock occurs at a favorable elevation for the foundation. This location was unusually favorable also in that there had been very little weathering of the upper rock layers (the depth being about 20 feet below the surface), the rock surface being so solid over much of the area that the concrete could be deposited directly upon it. In no case did more than a foot or a foot and a half of loose rock have to be removed to reach solid foundation. The bottom of the hydraulic mud pool was about 16 feet below the bottom of the conduit proper, requiring an excavation of 4,560 cubic yards of material. This constituted practically all of the rock at Lockington requiring to be removed.

On account of the unusually favorable winter of 1918-19, the concreting was enabled to follow closely upon the rock excavation at all times, and occasionally to overtake it. For this reason, with the materials at Lockington, heavy blasting was not necessary. It was found satisfactory to drill shallow holes with "Dip" rock drills and load with light charges. This light shooting broke the rock into sizes suitable for concrete "plums" and for the rip-rap referred to. It required more dynamite than would have been required if deeper holes had been sunk, but the excess cost was offset in several ways. The light shooting gave a smooth foundation line with practically no overbreakage. This in turn enabled the excavation for the two conduit foundations, adjacent to the bottom of the mud pool, to be reduced in cross section, the solid unbroken rock base and wall taking the place of concrete. There was no danger to the plant, to the finished work or to the foundation from the shooting, the entire work of excavating the rock being carried on in the dry. Derricks and dragline cranes were used to transport the concrete to the forms and to lift the rock removed.

The loose rock was removed by dragline excavator as at the other dams, but by one and three quarter yard bottom dump buckets loaded by hand and lifted by two guy derricks with 105-foot steel booms, which were used in connection with the concrete work. Much of the material was dumped directly into the concrete forms in the form of plum stones; the remainder was loaded into 5-yard dump cars, and hauled away to be built into rip-rap on the east side of the outlet channel, or to be used for other miscellaneous purposes.

FIG. 77—LIDGERWOOD DRAGLINE LIFTING WAGON DRILL, TAYLORSVILLE DAM.

This machine has a 100-foot boom and a 3½-yard bucket and is driven by electric motors, as are most of the other draglines used by the District. The wagon drills, also electrically driven, are moved to and fro as needed in the manner shown. U-bolts, fastened at each corner of the drill frame, are gripped by hooks carried by a 4-cable bridle, the upper ring of which is attached to the dragline bucket. The dragline is carried on trucks traveling on tracks running crosswise of the excavation, the latter being too wide to permit all the material to be reached from any one position. The machine thus zigzags back and forth up the excavation, taking out a slice at a time. Taken Dec. 18, 1919.

Taylorsville

The excavation for the outlet works at the Taylorsville dam is much wider, much longer, and also considerably deeper than any other on the Conservancy work, except in the railway cut at Huffman (See plan Fig. 78). The maximum depth is 100 feet, of which 77 feet is in rock. The maximum width is 380 feet. The length on the center line is 1850 feet, on the east edge 2900 feet. The total excavation is estimated at 773,000 cubic yards, of which 523,000 is earth, and the remaining 250,000 rock. It is evident from these dimensions and quantities alone that the Taylorsville excavation problem must present somewhat different aspects from those at the other dams. See Fig. 78.

Especially, the disposition of the 523,000 cubic yards of earth overburden must be considered. This material must be made use of in the dam embankment, and this means that it must be removed ahead of the rock which underlies it, since the rock, for reasons to be given later, is not permitted to be used in the dam except as an addition and safeguard. The hydraulic fill method of construction having been settled upon as giving the maximum economy with assured solidity and stability, most of the overburden was washed down by the powerful jet from a hydraulic "giant" or monitor.

The dimensions and quantities given in the first paragraph also indicate that at Taylorsville the ex-

cavation, exclusive of the hydraulicking, might be done, not by dragline alone, but by a combination of dragline with steam shovel, the latter carrying the excavation down to elevation 775 or 770 (14′ to 19′ below the working shelf in Fig. 74), and the dragline following and completing the operation. This would have speeded up the work of the dragline on its part of the job by reducing the height of bucket hoist, and would have turned over a very considerable yardage of excavation to the quicker swinging steam shovel. It was decided, however, that the difficulties involved in the method, principally in harmoniously coordinating the double excavation and track equipment necessary, made the work at Taylorsville, like that at the other dams, a dragline job.

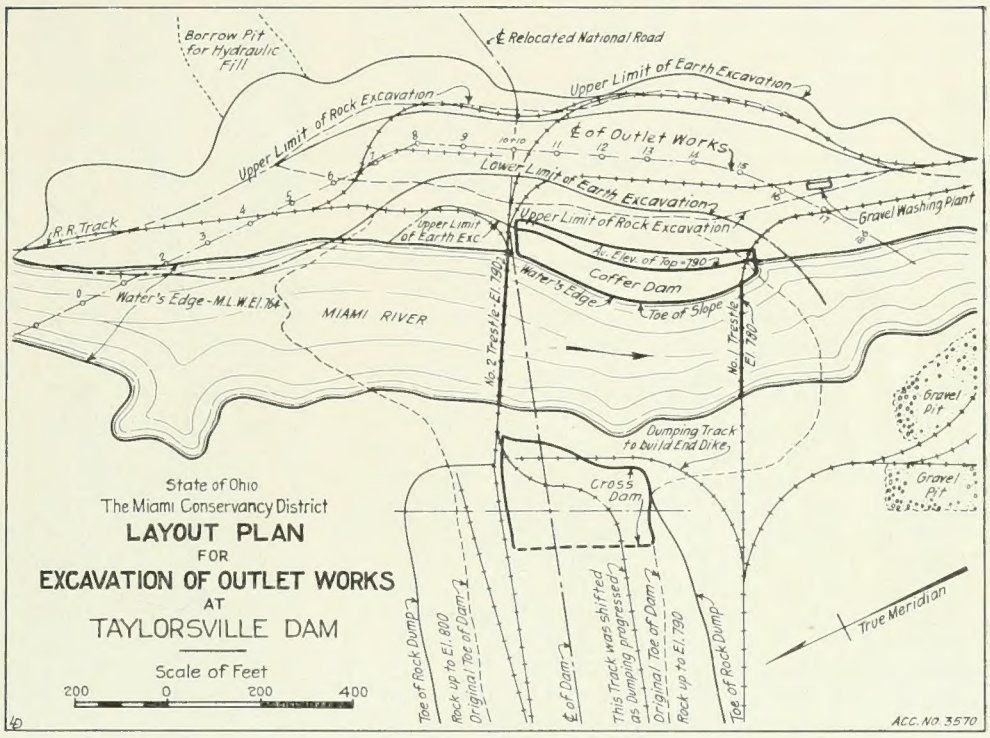

FIG. 78—LAYOUT FOR TAYLORSVILLE OUTLET EXCAVATION.

A small fraction of the material has been excavated by steam shovel and dragline, loaded into 12-yard dump cars, and carried across the river by locomotives, where it has been used to build the cross dam extending across the damsite just west of the river, and enclosing the hydraulic fill pool on the east. This took 30,000 cubic yards. The remaining portion, as already indicated, was jetted, sluiced, and pumped by the method of hydraulic fill into the main structure of the dam between the river and the old B. & O. Railway tracks. About 230,000 cubic yards have been thus disposed of and the process is to be continued. This material for hydraulic fill has been obtained mostly from the river bank north of the north trestle (See plan Fig. 78). About the upper 10 feet of this material as it lies in the bank is composed of glacial till or boulder clay, and is excavated without difficulty. Beneath this,

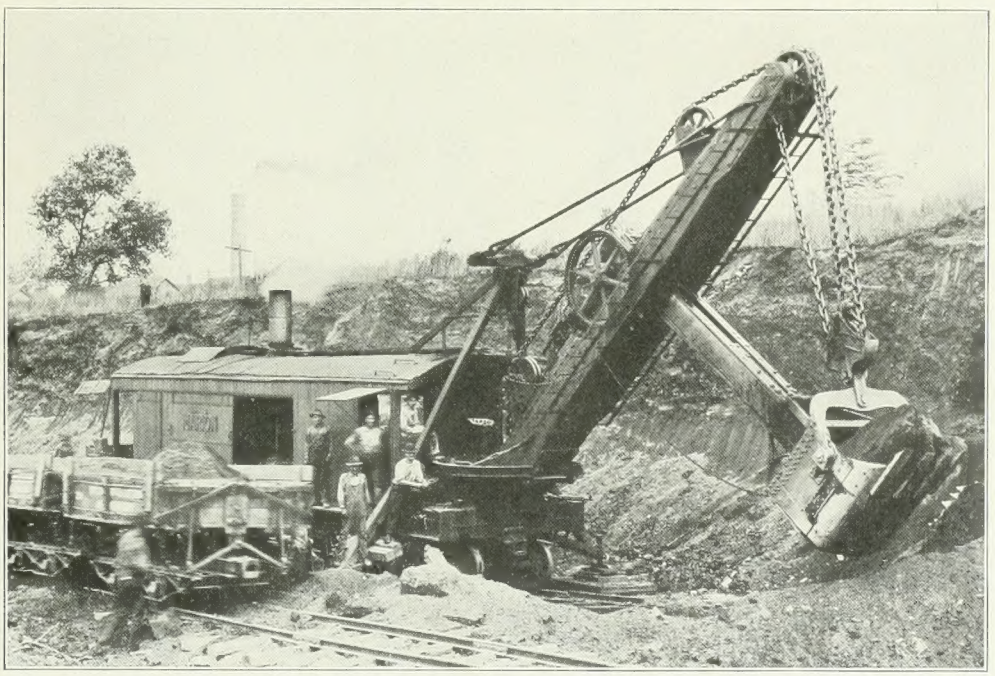

FIG. 79—STEAM SHOVEL AT HAMILTON, SEPT. 11, 1919.

A powerful Marion machine, of a type adapted to rock excavation. Note the compact, massive build of the boom and dipper. The dipper and dipper handle swing on the shaft of the biggest wheel (seen about the middle of the boom) as a center, and the dipper handle, as seen, is pushed out to its full stretch. The short reach, either down, up or sidewise, as compared with a dragline machine of equal power equipment (Fig. 77) is evident. This means that only a comparatively narrow trench can be taken out at one cut, and also that the dump car trains to be loaded must run rather close alongside the shovel. To take out a wide excavation, much side shifting, both of shovel and train tracks, is thus necessary to reach all the material. See pp. 89-90.

however, and extending down to the Cincinnatian rock, is a layer running to 20 feet or more in thickness, of extremely tough clay or hard pan, which was as hard on a steam shovel or a dragline as rock would be. It was found best in the end to blast it, and this was true whether it was to be removed by dragline, steam shovel or hydraulic monitor. The holes for this purpose were best drilled from above by well drills, spaced about two-thirds the height of the excavation to be shot, and loaded with black powder at the rate of about a pound per cubic yard, the holes having first been "sprung" or enlarged at the bottom by dynamite. The general arrangements for the excavation of this overburden by hydraulic fill have been described in the issues of the Bulletin for November, 1918, and March, 1919.

The earth excavation began in August, 1918, with the work of a Marion 36 steam shovel cutting a shelf for the big dragline to work on. Excavation of the overburden by hydraulic began in September, 1918, and has been continued with various necessary interruptions down to November, 1919, when it stopped until the Baltimore & Ohio tracks could be removed to their new location out of the way of the growing dam embankment. Rock excavation began in February, 1919, and has been steadily continued ever since. The total amount of the latter removed to December 1, was 141,130 cubic yards, leaving about 110,000 cubic yards still to be done.

The general arrangements for taking out the rock are in the main similar to those at the other dams. The chief tool relied upon for the digging is the dragline excavator, a Lidgerwood machine with 100-foot boom and 3½-yard bucket, loading into 12-yard dump-cars handled by 40-ton locomotives. The dragline works on a rock shelf at elevation 789. The loading tracks are laid on the same shelf and run to the north trestle on a level grade. The south trestle is ten feet lower than the north one, (see plan Fig. 78) and the general elevation of the valley floor on which the dam is built is 770. The rock being deposited, as explained later, as a buttress to the low outer slopes of the dam embankment, this arrangement permits the loaded trains to move on level or downward grades. About 6,000 yards of rock lying above the working shelf elevation, as well as a considerable yardage of the earth overburden, was removed by steam shovel. The rest is being taken out by the dragline. All the material is carried across the river on the trestles, almost all of the dam embankment being west of the stream, and the outlet works excavation being on the present east bank.

It has been stated before that in taking out this rock at Taylorsville a record for deep excavation with a dragline is believed to have been made. The machine stands on a rock shelf at elevation 789. The bottom of the hydraulic jump pool, the lowest point in the excavation, is at 726. The lowest material was thus removed at a depth of 63 feet below the supporting rock shelf.

The rock was drilled and blasted in two lifts. The upper lift was carried down 26 feet, taking it to the bottom of a heavy seam of the Cincinnatian limestone. Where the holes were carried deeper this thick seam would break out in blocks 3 to 5 feet thick, which would require to be "block-holed;" that is, drilled and blasted again, to break them into pieces small enough to be handled by the dragline bucket. With the main charge exploded at the base of this seam block-holing was not necessary. The second lift was carried down to the bottom of the excavation, a maximum distance of 37 feet below the first.

The drills used were three cyclone drills and three air drills of smaller size. The cyclone drills were driven by 7½ H. P. alternating current three phase motors, operating at 440 volts and drilling a four-inch hole. Fifty feet of hole per day was considered a good day's work. The holes were spaced 10 feet each way and up to June were charged with 40 per cent dynamite. Following that, "gelignite" was used, a 72½ per cent gelatin dynamite, which had been sold to Italy for use in the war and on the conclusion of the armistice was advantageously taken off the Italian government's hands by the Conservancy District for its own use. An amount of this explosive ranging from 75 to 100 pounds was used in each hole. The holes were not "sprung;" that is, a small charge of dynamite was not exploded at the bottom of the hole to enlarge it for a bigger charge. Ordinarily this process is an advantage, but in the Cincinnatian it cannot be used, the reason being that the springing charge "funnels out" the top of the hole, the strata being thin and weak, and the broken rock drops down the funnel into the hole, blocking it and making it necessary to re-drill.

The large holes were not carried nearer than two feet from the bottom of the excavation nor nearer than five to ten feet from its sides. These remaining portions were drilled by jap and jack hammer drills and shot with small charges of from one to two pounds of dynamite. These holes were drilled three feet apart, and next the sidewalls four to six feet deep, the holes on this latter case being drilled at the very edge of the excavation. The caps were exploded by electricity tapped from the 440 volt motor line. On the day of the editor's visit 235 of these holes were fired at once in this manner by a single stroke of the electric switch.

The quantity of dynamite used per cubic yard of rock blasted has been 0.72 pounds of the 40 per cent explosive and 0.5 pounds for the gelignite.

It would have been desirable if the rock material could have been used in the dam structure, but fears have been entertained for the stability of the Cincinnatian formation, the particular rock encountered, in such a situation. The rock is limestone, for the most part in thin layers and interstratified with much shale, which on exposure to air, frost, and water, sloughs and decomposes in such a way as to create considerable distrust regarding its ability to stand without sliding when placed in the dam embankment. For this reason it is not placed in the dam structure proper, but is deposited as a blanket and buttress adjoining the dam to the north and to the south. Thus used, it becomes a strengthening extension of the very flat outer slopes of the dam embankment.

It is believed to be worth while to call attention once more to the remarkable flexibility of the dragline as an excavating machine, as exhibited on this work. The total depth of the Taylorsville excavation at its maximum is just 100 feet. The Lidgerwood machine, with its 100-foot boom and 3½-yard bucket, standing on its work shelf, as described, excavated over this entire range, reaching up and

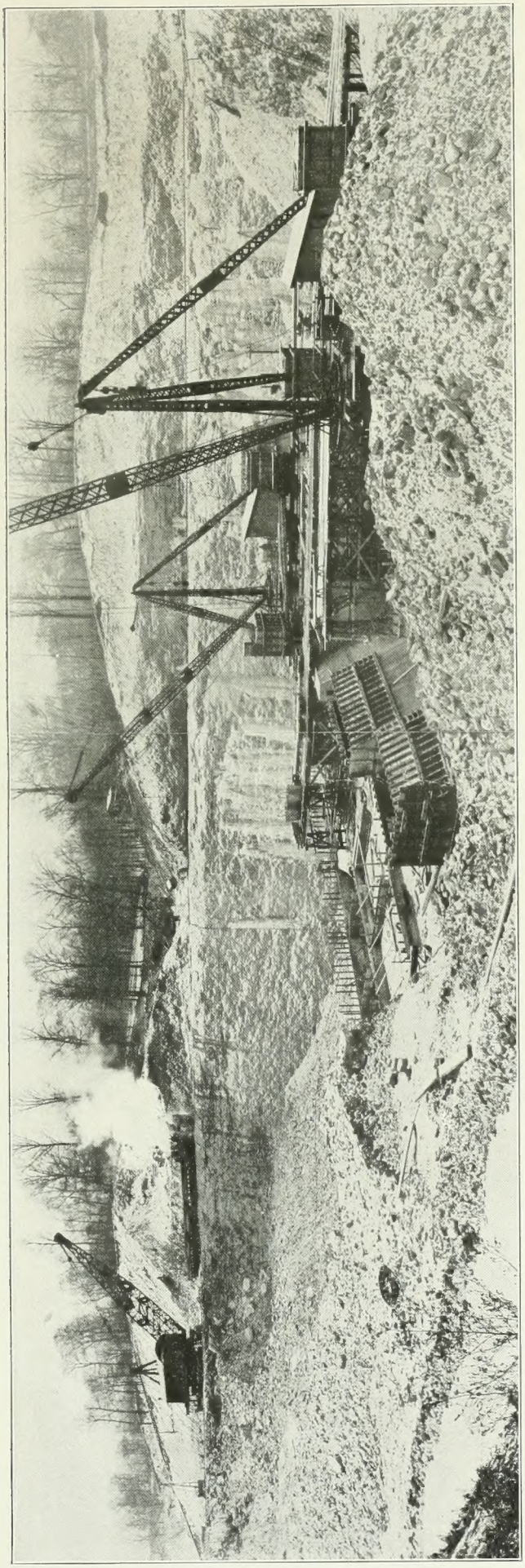

FIG. 80—FOLLOWING UP THE ROCK EXCAVATION WITH CONCRETE WORK, TAYLORSVILLE DAM, DEC. 18, 1919.

"browsing" 37 feet above its base, and then reaching down 63 feet into the pit, to pick up the material which was there. It could no doubt also have taken out the excavation to a 175-foot base width by running down the center line and reaching out on each side, since the Bucyrus machine at Huffman, with a 100-foot boom, did such a feat on an excavation of that width. The extreme breadth of the Taylorsville excavation, however, did not permit this. The machine was obliged to "seesaw" back and forth crosswise of the excavation while it worked down the length of it, and take the rock out a slice at a time.

Equipment for Sale

On this page will be posted from time to time a list of the equipment for which the Conservancy District has no more work in prospect. All of this equipment will be completely overhauled in our own shops, and any one interested in any item may rest assured that it will leave our hands in first-class working condition.

The following items are now on sale:

6 **Sullivan FL-3—3¼" Cylinder Tripod Drills.**

8 **Ingersoll E-44—3¼" Cylinder Tripod Drills.**

Above are all complete with tripods and weights, steel in various lengths, connections, and a full line of repair parts.

7 **Sullivan DP-33 Rotator Jack Hammer Drills** with steel hose connections and all necessary repair parts to keep them in service.

All inquiries relative to the above should be addressed to the Miami Conservancy District, Dayton, Ohio, marked for attention of Fowler S. Smith, Purchasing and Sales Agent.

Excavation and Concreting at Taylorsville

The picture of the Taylorsville work on this page is intended to bring out, among other things, one of the chief reasons for the choice of dragline equipment to excavate for the outlet works at the Conservancy dams. It shows the dragline working up the trench on its job of excavation, and further down, at the right, the work on the concrete proceeding simultaneously. The nearest wall seen is the lower weir wall for the hydraulic jump pool, at the downstream end of the outlet works. The further wall is that of the upper weir, the pool floor being between. The dragline completed this part of the excavation first, to full depth and width. Then the concreting began, while the dragline excavated on ahead. A steam shovel would have been obliged to take out almost the entire outlet works excavation, from end to end, before concreting could begin at all. (See pages 89 and 90). This greatly expedited the concrete work, a matter of much importance.

At Taylorsville the great width and depth of the excavation (the maximum cut in the picture being 100 feet), made it necessary to excavate the upper part first, down to the level of the rock shelf on which the dragline and train stand. (Elevation 789). Then the lower part was attacked, beginning at the right-hand end in the picture, and working to the left (upstream.)

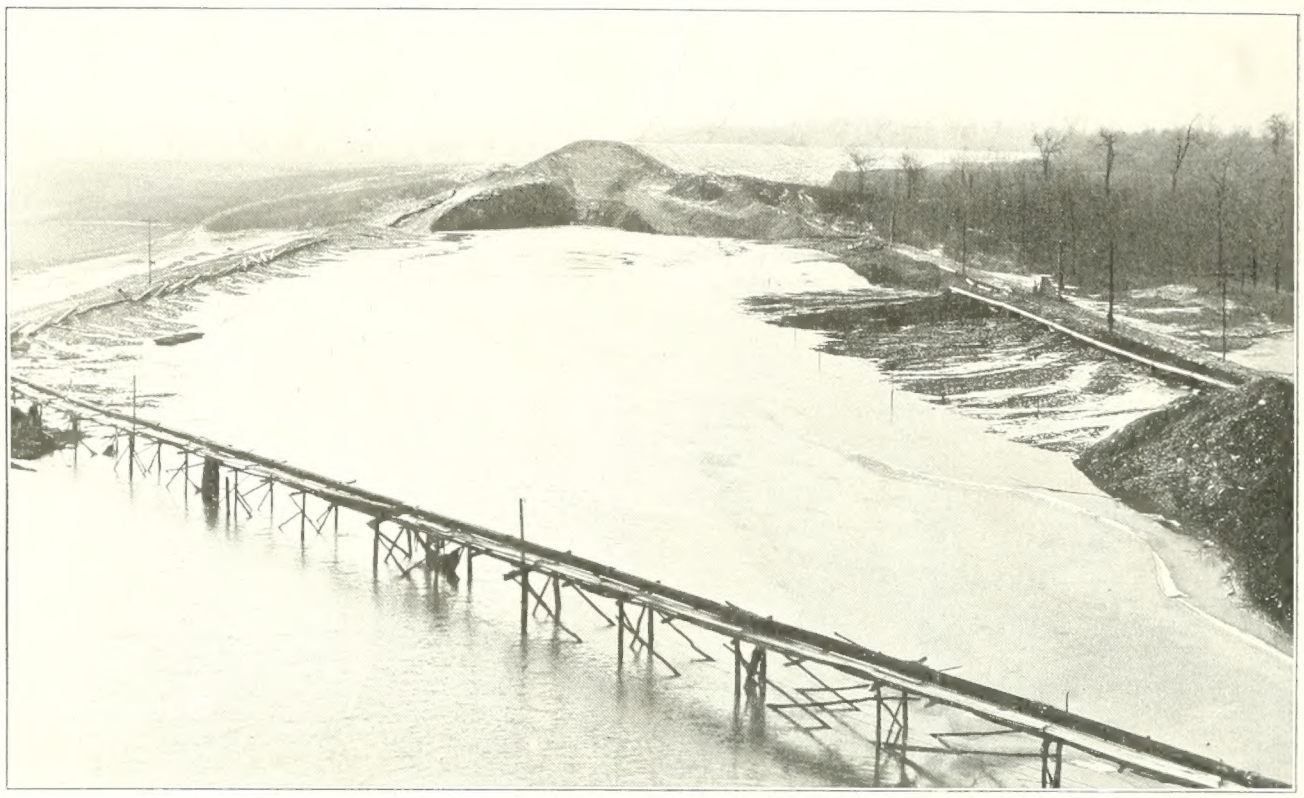

FIG. 81—LOCKINGTON DAM EMBANKMENT, DEC. 8, 1919.

The view is westward from the top of the west wall of the outlet works (the left hand wall, Fig. 82 below). In the foreground is the hydraulic fill pool, with its enclosing levees on the north and south. The trestle carries the dredge pipe line across the pool to the south levee. In the distance, in the middle of the picture, is the east end of the narrow western half of the dam embankment, recently completed. This portion, averaging only 15 to 20 feet high, can be seen sweeping to the northwest where it ends behind the trees at the right. It was built by a dragline excavator, the material being scooped up out of a "borrow pit" at the side. It is 3400 feet long, (the entire length of the dam being about 7000 feet), and contains 101,000 cubic yards of earth. Material totalling 195,000 cubic yards has been deposited in the embankment from the pool by hydraulic fill. Total earth in the finished structure will be 1,000,000 cubic yards. The embankment seen in the distance is up to full height (elevation 954 above sea level). Hydraulic fill embankment seen is up to an average elevation 42 feet below this. The concrete walls and foundations for the outlet works (see Fig. 82 below) are completed. The dam as a whole is 64% complete. Closure of the dam is expected to be made next season, sufficient to give Piqua and Troy, immediately below, protection against a flood equal to that of 1913. By the end of the season, it is hoped, the concrete spillway will be finished and the embankment carried to full height, giving the full protection planned. Total earth in the embankment to date is 392,000 cubic yards.

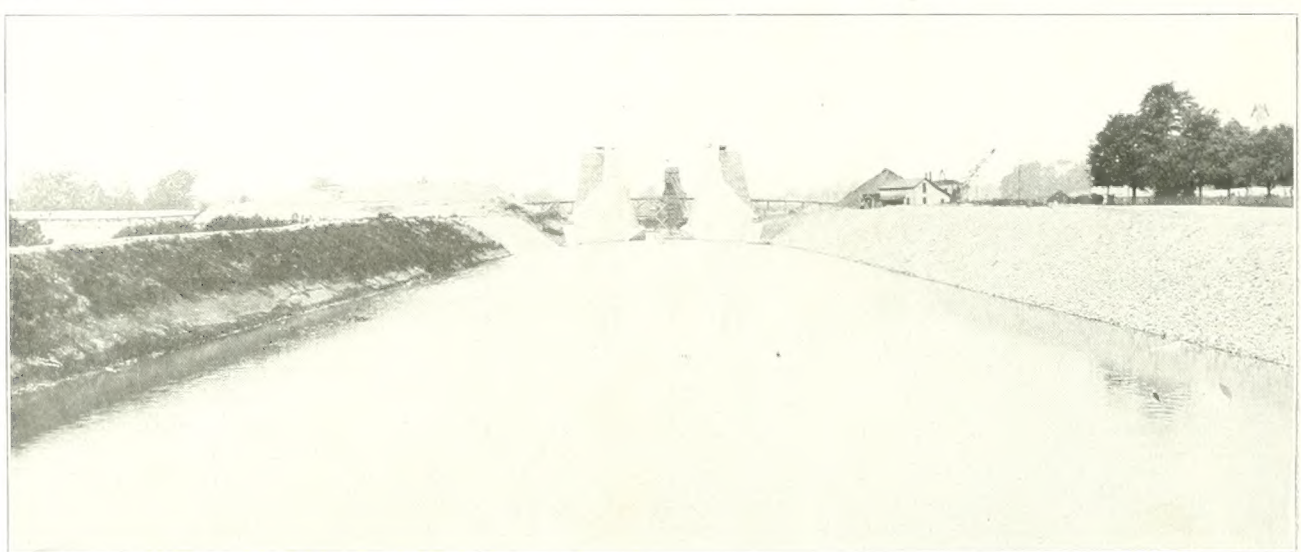

FIG. 82—OUTLET CHANNEL AND WALLS OF OUTLET WORKS, LOCKINGTON DAM, AUG. 11, 1919.

The view is looking north. The hydraulic fill pool shown in Fig. 81 is just to the left of the left wall of the outlet structure, on top of the unfinished dam embankment, (which appears in Fig. 82). A concrete cross dam will block the space between the outlet walls. It will be pierced at the base by the two conduits, carrying Loramie Creek through the dam. At the top, between the walls, it will carry the spillway.